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Rapid Service Design for Healthcare Facilities in the COVID-19 Context: Methodological Approaches to User Research, Analysis, Design and Evaluation

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ABSTRACT

Background: The demand for rapid service design in the medical field has increased due to the COVID-19 pandemic. Concurrently, the deployment of service robots is expected to alleviate the chronic shortage of nurses. However, introducing new technologies necessitates behavioral changes among users, which presents a barrier to implementation. This study aims to develop a rapid and effective service design method to address these challenges.

Methodology: This study introduces a new service design method that integrates Rapid Ethnography and Behavioral Design. The method comprises four steps: research, analysis, design, and evaluation. In the research phase, we focus on the roles of the main information provider and the three institutional elements (regulative, normative, cultural-cognitive). In the analysis phase, data is examined using qualitative text analysis. The design phase involves creating new services based on existing jobs, using the identified institutional elements as constraints. In the evaluation phase, the CREATE action funnel is used to assess psychological barriers to service adoption.

Results: Utilizing the proposed method, we designed and implemented two services (hospital room and examination room guidance) at Shonan Kamakura General Hospital within approximately two months. During the demonstration experiment, we evaluated the services with two nurses. Although several user interface and user experiece improvement points were identified, the service concepts received positive feedback. Additionally, there was potential for operation by non-nursing staff, and the services were expected to reduce the workload of nurses.

Conclusion: The rapid service design method proposed in this study demonstrated that it is possible to effectively design and implement services that consider behavioral changes during emergencies such as the COVID-19 pandemic. However, limitations exist, including the absence of patient-side evaluation data, the evaluation at a single facility, and the lack of long-term effect validation. Future studies should aim to improve the method's effectiveness and generalizability through verification at various medical facilities and the measurement of long-term outcomes. This method also holds potential for application in new public and corporate services outside the medical field, warranting further research.

Keywords: rapid service design, rapid ethnography, behavioral design, service robots, digital twin, healthcare

Introduction

In the context of the COVID-19 pandemic's impact, there is a need for more rapid research and design in the service design process. In the medical field, there has always been a need for rapid service design. However, due to the impact of COVID-19, the number of patients has increased, and working hours have lengthened[1]. Additionally, several papers have reported an increase in psychological stress as a result of the increase in working hours[2]. Furthermore, in accordance with CDC(Centers for Disease Control and Prevention) recommendations, strict restrictions have been imposed on the entry and exit of outsiders into hospitals[3]. Under these circumstances, it is difficult for service designers to conduct sufficient observations and interviews in the field.

To achieve rapid research, a method called Rapid Ethnography (RE) has been proposed in the field of Human Computer Interaction (HCI). Rapid Ethnography, which originated in the field of HCI, is defined as "a collection of field methodologies"[4]. It was originally proposed as a method for rapid assessment and evaluation in the public policy field, with the aim of quickly assessing the field[5]. It has since spread to HCI and is being discussed in relation to design. It has been particularly developed in the medical field[6-8], and has also been applied in the fields of entrepreneurship[9], and finance[10]. However, a rapid service design method has not yet been established.

Even before the outbreak of COVID-19, there were concerns about a shortage of labor in the medical field, and the introduction of service robots was expected to address this issue[11]. The use of service robots has the advantage of not only preventing the spread of infection and reducing human error, but also reducing the opportunities for frontline staff to come into direct contact with patients, allowing them to focus their attention on higher priority tasks and avoid direct exposure to infection[12]. However, there are also issues such as patients being reluctant to accept new technology[13] and care providers being unwilling to accept robots[14,15]. In order to introduce service robots and perform various tasks in collaborative tasks in medical settings, it is necessary for humans to change their behavior to suit these mechanical assistants.

Based on these situations, we set the following research questions (RQs) for the purpose of establishing a 'rapid service design method' for designing services that utilize robots.

- RQ1. What characteristics should be introduced to each step of the design process, such as research, analysis, design, and evaluation, in order to design services rapidly?
- RQ2. What theories, tools, and methods should be introduced in each step of the design process, such as research, analysis, design, and evaluation, in order to rapidly design services with robots rather than just services?

In this research, we first conducted a literature review with the aim of developing a 'rapid service design method' and summarized its implications. Based on these implications, we proposed a rapid service design method. As a case study, we selected Shonan Kamakura General Hospital as the field, and introduced the process of designing a new service based on the proposed method. We conducted an evaluation experiment targeting the potential users, and verified the validity of the new service and the proposed method through post-interview and questionnaire surveys.

The authors made the following contributions:

- We proposed a new service design method that introduces Rapid Ethnography into the stages of research, analysis, design, implementation, and evaluation, and developed and evaluated two services in a short period of about two months from research to implementation.
- Using the proposed method, we designed and implemented two services (hospital room guidance for patients and examination room

guidance) that utilize robots in actual hospitals, and verified their effectiveness.

- We conducted research and analysis focusing on three institutions (regulative, normative, and cultural-cognitive elements) and jobs, and proposed a design method for services involving robots that takes these as constraints, and achieved a design that takes into account behavioral changes accompanying the introduction of new services.

Prior researches

RAPID ETHNOGRAPHY

Before RE was introduced into the field of HCI by Millen et al. in 2000, Rapid Ethnography was used to evaluate the current state of voluntary programmes and services in public policy, such as healthcare, and was not linked to design. McNall et al. used HIV/AIDS integrated medical intervention research as a case study, arguing that 'when programme managers need rapid and focused evaluation of specific programme processes, RFE (Rapid Feedback Evaluation) is preferable to comprehensive evaluation models, as it aims to provide timely evaluation results that are more focused on programme managers'[16]. Additionally, McNall et al. compiled descriptions of 13 projects that used Rapid Evaluation, Assessment, and Appraisal in the field between 1988 and 2005, specifically, responses to humanitarian crises (Real-Time Evaluation), HIV/AIDS primary care programmes (Rapid Feedback Evaluation), HIV/STI infection patterns (Rapid Assessment), healthcare systems (Rapid Evaluation Methods), and the management of local natural and human resources (Participatory Rural Appraisal). They point out that the central issue when using rapid evaluation and assessment methods (Rapid Evaluation and Assessment Methods) is 'balancing speed and reliability'[17].

Vindrola-Padros et al. conducted a systematic review of Rapid Ethnography in the context of healthcare organisations[5]. Their paper reviewed 26 papers and explored the benefits and challenges of using Rapid Ethnography. Specifically, they pointed out the need for more detailed descriptions of research design and the delays caused by ethical governance processes. Based on their review, Vindrola-Padros et al. proposed a definition consisting of six requirements:

1. The research is carried out over a short, compressed or intensive period of time
2. The research captures relevant social, cultural and behavioral information and focuses on human experiences and practices
3. The research engages with anthropological and other social science theories and promotes reflexivity
4. Data are collected from multiple sources and triangulated during analysis
5. More than one field researcher is used to save time and cross-check data
6. Research designs and the steps involved in the implementation of the study are reported clearly in publications and other forms of dissemination

Millen et al. introduced RE into the field of HCI and organized its characteristics into three points:

1. Appropriately narrow the focus of field research before entering the field. Zoom in on important activities. Use key informants such as community guides and members of liminal groups
2. Use multiple interactive observation methods to increase the likelihood of finding exceptional and useful user behaviour
3. Use collaborative work and iterative computer-based data analysis

Tedjasaputra et al. proposed a method called pair writing with the aim of complementing RE for HCI by Millen[19]. This method aims to verify the results of ethnographic research and fill knowledge gaps by having stakeholders from different fields collaborate to create scenarios.

RAPID SERVICE DESIGN

The general service design process is based on the human-centred design (HCD) process specified in International Organization for Standardization (ISO)[19], and consists of research, ideation, prototyping, implementation, measurement and improvement[20]. In the research phase, we deepen our understanding of the context of the service, the needs of users, and the stakeholders involved. In the conceptualisation phase, ideas for improvements and new services are created based on the insights gained in the research phase. In the prototyping phase, the created prototypes are tested in a real environment to find areas for improvement. In the implementation phase, the service design is transferred to actual operation. In the measurement and improvement phase, the service is evaluated regularly after it has been introduced, and performance is improved.

As an example of an attempt to introduce ethnography into service design, similar to this paper, the paper by Segelström et al. can be cited[21]. Segelström et al. focused on the three definitions of ethnography by Malinowski and attempted to reflect them in the service design process. Specifically, 1) they used ethnography as a method for empathizing with future users of the service, and 2) they used ethnography to encourage idea generation. However, since the example given by Segelström et al. is not Rapid Ethnography, it is difficult to use these methods as they are.

Design Sprint[22] is a method that combines rapid research and service design. Design Sprint is defined as 'a time-constrained, five-phase process that uses design thinking with the aim of reducing the risk when bringing a new product, service or a feature to the market' and was originally developed by Google Ventures. The aim is to create a prototype in five days, but since it does not include research on the field or customers, and only interviews with potential customers are conducted when verifying the prototype, it is inevitable that the context will not be fully understood.

A case study that combines rapid research and service design is the project to transition to online consultations at the Princess Margaret Cancer Centre during the COVID-19 pandemic[23]. They established a triple diamond process, an extension of the double diamond[24], and involved people on the front line in all processes, from discovery, design and test, to implementation and improvement. As a result of designing the transition process, the goal of a 50% transition from in-person care to virtual care was achieved in four days. The findings of this case study include the fact that the VCMS (Virtual Care Management System) team mapped and analysed each step of the conventional outpatient workflow and 'identified critical bottlenecks that hindered the provision of virtual medical care'.

BEHAVIOURAL DESIGN

As a result of rapid service design, when introducing new services into an organisation, behavioural change inevitably occurs for the part of those operating the service and those benefiting from it, so it is necessary to introduce measures to deal with behavioural change into the service design process.

Wendel et al. have proposed a framework called the CREATE Action Funnel, which is based on psychological and behavioural economics research and identifies five cognitive preconditions that determine human behaviour[25]. These five cognitive preconditions are Cue, Reaction, Evaluation, Ability and Timing.

- Cue - the trigger that gets you thinking about taking a specific action
- Reaction - your instinctive first reaction to the idea of taking the action
- Evaluation - a more rational cost vs benefit analysis of taking the action
- Ability Check - seeing whether you can even take the action right now
- Timing - determining whether it's urgent to take the action right now

Takeyama et al. have proposed a method[26] consisting of three steps that promote behavioural and

institutional change simultaneously, integrating the approach of Wendel et al. and the service ecosystem design of Vink et al.[27]. In the first step, the CREATE action funnel framework is applied to identify the factors from the five cognitive preconditions that determine people's behaviour. In the second step, the system is analysed from a psychological perspective. In the third step, a strategy for behavioural and institutional change is designed.

Vink emphasises the role of institutions within the service ecosystem, such as rules, norms and beliefs, which limit or enable the behaviour of actors within the system. Palthe identifies the following as inhibitors to organisational change: regulative elements related to laws such as work rules, normative elements related to morals and ethics such as work norms and habits, and cultural-cognitive elements related to individual perceptions of beliefs and values[28]. Based on these factors, Vink has clarified that in nursing homes, behind the visible experimental elements, i.e. the elements that people can see, hear and feel on the spot, there are invisible social structures, i.e. the regulative, normative and cultural-cognitive elements, and that service design that takes these into account is required.

Tokuhisa et al. introduced Vink et al.'s invisible social structures, namely, regulative, normative, and cultural-cognitive elements, into the service design process and constructed a method for mitigating resistance to service robots[29]. Specifically, they extracted the jobs of various actors in elderly care facilities and allocated them to human and non-human actors based on the regulative, normative and cultural-cognitive elements.

Datta et al. have summarised the key insights of behavioural economics into a concise framework of the constraints people face when making decisions, with the aim of designing development programmes and policies[30]. These elements are thought to be related to Vink's cultural-cognitive elements.

Lockton et al. propose the Design with Intent Method for the purpose of designing products and systems that influence user behaviour[31]. It uses six lenses, a series of 'primary' design patterns that can be applied to a wide range of target behaviours for inspiration, and 11 prescriptions to achieve the intended results and specific user behaviours. The limitation of this method is that it is mostly related to problems that have already been 'solved'.

DESIGN IMPLICATION

Based on the three previous research reviews of Rapid Ethnography, Rapid Service Design, and Behavioral Design, the 'rapid service design method' proposed in this paper has the following characteristics.

The steps of the research have the following three characteristics.

1. Focusing the field research appropriately: using key informants
2. Focusing the field research appropriately: zooming in on important activities (three institutions and jobs)
3. Collaborative field research

These three characteristics are based on the characteristics of RE for HCI proposed by Millen[4]. This enables rapid and accurate analysis. In addition, we focus on the three institutions pointed out by Palthe[28] as important activities to zoom in on. This is to clarify the key elements of behaviour change while taking into account the second characteristic of RE (2. The research captures relevant social, cultural and behavioral information and focuses on human experiences and practices) as organized by Vindrola-Padros et al. [5]. Another important activity is to focus on jobs. This is based on the findings of Tokuhisa et al. [29], who extracted the jobs of each actor and assigned the main jobs to human actors and the other jobs to non-human actors in order to reduce human resistance to service robots.

The analysis step adopts 'data analysis in collaborative work'. This is based on the fifth characteristic of RE (5. More than one field researcher is used to save time and cross-check data) as organized by Vindrola-Padros et al.[5]. This enables rapid and accurate analysis.

The design step is 'service design based on existing jobs, with the three institutions as constraints'. When introducing a new service, it is essential to change the behaviour of the service beneficiaries. With the aim of reducing the psychological resistance to behavioural change on the part of the service beneficiaries, we will consider what jobs to assign to robots when introducing a new service, based on the job allocation proposed by Tokuhisa et al. and taking the existing jobs and the system as constraints.

The implementation and evaluation steps will have the following two characteristics.

1. Evaluation will be carried out based on the CREATE funnel.
2. Each step of the workflow will be mapped and used for evaluation.

Firstly, the characteristics of the action design proposed by Wendel et al.[25] will be given. This is because we thought that by evaluating using the CREATE funnel, it would be possible to evaluate whether the five cognitive preconditions for human action decisions were being taken into account.

Secondly, we also made it have the characteristics of the rapid service design proposed by Rodin et al. [23], because we thought that visualising each step and explicitly presenting it to the people on the front line would promote understanding of the inhibiting factors.

Methodology

Based on the design knowledge in 2.4, we developed a 'rapid service design method' with the aim of designing services that utilize robots (Figure 1). Service designers who use this method are required to have a variety of skills and knowledge. Specifically, field research methods and qualitative text analysis methods are used in the research, analysis and evaluation steps. In the design step, basic design tools such as personas[32], which refer to the profiles of specific people such as customers or user groups, market segments, and other stakeholders, journey maps[33], which describe the touch points between service providers and service beneficiaries at each stage and step, and service blueprints[34], which describe the service provision process by dividing it into a front stage that is visible to customers and a back stage that is not visible to customers, are used to create detailed concepts.

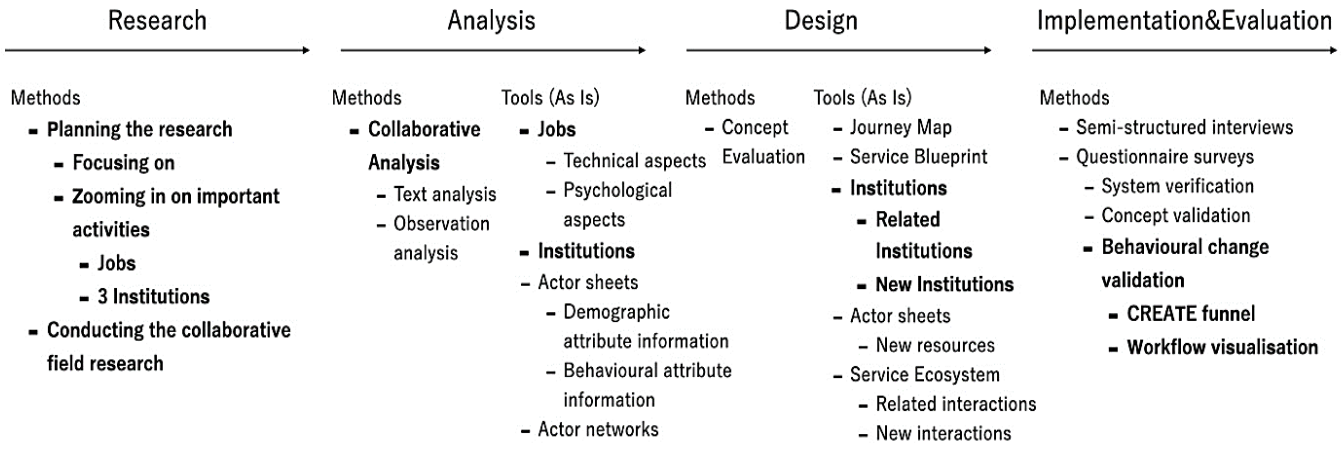

Figure 1: 'Rapid Service Design Method' for the purpose of designing services that utilize robots. The features unique to this method are indicated in bold.

RESEARCH

1) Focusing the field research appropriately: using key informants

2) Focusing the field research appropriately: zooming in on important activities (three institutions and jobs)

3) Collaborative field research

The first step is research. During the planning stage of the fieldwork, the focus of the field research is narrowed appropriately. The actual fieldwork is carried out by multiple people, and through interviews and observations, you zoom in on important activities. Specifically, you obtain data on the jobs of key informants, and you look for jobs that should be replaced by robots instead of humans. You also obtain data on the three institutions, and you use them to select jobs that can be left to humans.

ANALYSIS

Collaborative data analysis

The second step is analysis. The data obtained through fieldwork is analysed by multiple people. Here, you use qualitative text analysis methods[35] to extract the three institutions and jobs. You compile actor sheets that include demographic and behavioural attribute information for each actor, with the aim of creating personas and journey maps. In addition, you will put together an actor map that includes the connections and relationships between actors, with the aim of analysing the service ecosystem.

DESIGN

Designing services based on existing jobs, with the three institutions as constraints

The third step is design. Based on the results of the analysis, you will design services based on existing jobs, while using institutions as constraints. Based on the existing jobs that have been identified and the institutions that have been identified for each field, you will finalize the jobs assigned to the robots and design the details of the new service. Specifically, you will create journey maps and service blueprints. At this point, not only do you organize the existing institutions and services that are relevant, but you also design new institutions and services as necessary. Furthermore, when creating the service ecosystem that is necessary for operating the service, you organize the new interactions and new resources that are necessary for the actors in the new service. After the detailed design of the service, you can bridge the gap between the service provider and the beneficiaries by presenting the service concept to the stakeholders.

IMPLEMENTATION AND EVALUATION

1) Evaluation will be carried out based on the CREATE funnel.

2) Each step of the workflow will be mapped and used for evaluation.

The fourth step is implementation and evaluation. When verifying the service after implementation, you will clarify the psychological barriers to introducing the service based on the CREATE funnel through interviews and questionnaire surveys. At this time, it will be possible to conduct specific studies by mapping the content of behavioural changes that occur before and after the introduction of new services and showing them to stakeholders.

Case Study

PROJECT OVERVIEW

Based on the proposed method, we carried out a service design project at a medical facility. The main body of the service design project was Toppan Holdings Inc., the world's largest printing company with its base in Tokyo. Toppan is developing a wide range of business activities in three fields based on 'printing technology': the 'information and communication business field', the 'life and industry business field', and the 'electronics business field'. Two service designers from Toppan participated in this project, and the author participated as a consultant on service design.

The client for this project was Shonan Kamakura General Hospital. Shonan Kamakura General Hospital is a private general hospital in Kamakura City, Kanagawa Prefecture, with 658 beds.

This project required a service design using Toppan's digital twin system 'Transbots'[36] at Shonan Kamakura General Hospital. TransBots is a digital twin solution that uses Virtual Reality (VR) and Computer Vision (CV) technologies to centrally manage and control multiple different types of service robots.

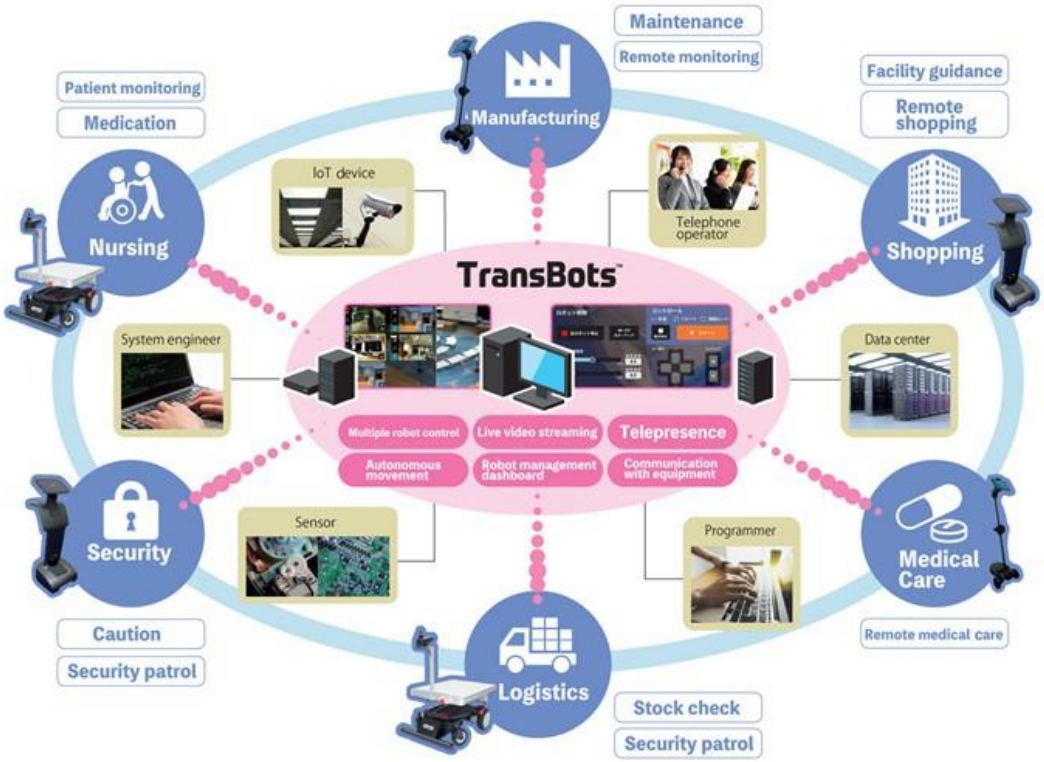

Figure2 : TransBots

RESEARCH

First, we decided to concentrate our field research on the job of a nurse, in order to narrow down the focus of our investigation appropriately. This is because there is a chronic shortage of nurses in the Japanese nursing labour market. For example, The Sixth Report of the Study Group on the Supply-Demand Outlook for Nursing Staff by the Ministry of Health, Labour and Welfare[37] predicted that there would be a shortage of approximately 42,000 nurses in 2006 and approximately 16,000 nurses in 2010. The Seventh Report of the Study Group on the Supply-Demand Outlook for Nursing Staff [38] predicted that there would be a shortage of approximately 56,000 nurses in 2011 and approximately 15,000 in 2015, and there has been no improvement. In this situation, in addition to making the work of nurses more efficient, it is necessary to reduce the burden by sharing the work.

We conducted the interview on 21 December 2021 at Shonan Kamakura General Hospital with two people targeting Ms. A, who is a leader of nurses. The list of interview questions is shown in Table 1. The interview lasted 90 minutes.

Table 1: List of interview questions

Purpose	Questions
Job identification	Q1: What types of jobs are involved in a typical day's workflow?
	Q2. How would you rank each job in order of importance?
	Q3. When do problems or difficulties arise in a series of jobs?
Institution identification	Q4. What work rules do you follow?
	Q5. What are your team rules?
	Q6. What are your personal work beliefs and philosophies, if any?

ANALYSIS

We conducted a qualitative text analysis of the data obtained through the interviews. First, we transcribed all the interview results and converted them into text data. Next, we coded the pre-determined coding targets of institutions' and 'jobs'. For instituions, we coded the three elements of Regulative, Normative, and Cultural-Cognitive Elements separately. For jobs, after extracting the jobs, we also extracted the functional and psychological aspects of the jobs. As a result of the analysis, we extracted 4 regulative elements, 7 normative elements, 7 cultural-cognitive elements, and 15 jobs (Tables 2 and 3).

Table 2: List of Institutions

Regulative elements	Normative Element	Cultural-Cognitive Eelemets
R-1: There are designated areas in the hospital where calls can be made.	N-1: There is no rule that the nurse in charge must take the patient to their room.	C-1: Some patients complain about using smartphones. Operating a device while talking to a patient is not a good impression.
R-2: Double-checking medication between nurses.	N-2: Using notebooks to make sure everyone is aware.	C-2: If you explain the pitch of the nurse call, people will accept it.
R-3: Confirming the patient's name and date of birth, explaining why they need to take their medication.	N-3: Making sure everyone is following the manual.	C-3: People have doubts about text input on mobile phones.
R-4: Double-checking is an absolute rule in the medical field.	N-4: We use the electronic medical record system that we have (rather than following a team policy, due to a lack of hardware).	C-4: We try to give patients a polite explanation.
	N-5: When guiding a patient, we stand next to them, at a distance where we can support them immediately if anything happens.	C-5: Explanations are given either by actually trying to do something or verbally, depending on the nurse.
	N-6 When entering a large ward room, enter without saying anything, call out to the patient from in front of the curtain, then pull back the curtain and speak.	C-6 In internal medicine, listen to the patient's complaints and be supportive.
	N-7 After catheterisation, use a wheelchair.	C-7 Always go to the patient's bedside to get first-hand information.

Table 3. List of jobs

Current job	Technical aspects	Psychological aspects	Frequency
J-1. Reception	Reception of patients at the nurse's station.		
J-2. Checking admission documents	If there are any omissions, have them filled in on the spot, or have them filled in after showing them to their room.		
J-3. Guide the patient to their room	On the way, guide them to the toilet etc,. and explain the room facilities (basically, the nurse who received them will deal with this, but be flexible).		
J-4. Visit to the patient's room	If there is an examination on that day, guide them to the examination For patients in private rooms, call out to them by knocking on the door.		Frequent
J-5. [Cardiovascular] Check the examination schedule	Check the catheter examination schedule at the outpatient department.	Psychological burden due to complaints about the way the examination is explained and the attitude of the staff.	25 cases/day
J-6. [Stroke] Checking the examination schedule	Explaining the catheter examination schedule in the patient's room.	Psychological burden from complaints about the length of waiting time, how the examination is explained, and attitude.	3 cases/day
J-7. [Cardiovascular] Examination			10 cases/day
J-8. Changing position, hygiene management, toilet assistance (internal medicine ward)		Psychological burden from complaints about how to wipe the body, how to give guidance, how to handle stretchers, etc. Feeling inconvenienced by the physical work involved in changing the position of patients with heavy bodies and assisting with pressure ulcers during body-wiping.	

Current job	Technical aspects	Psychological aspects	Frequency
J-9. Examinations, explanations, preparations (surgical wards)		Psychological burden from complaints about the length of waiting time, the way examinations are explained, and attitude.	
J-10. Temperature and blood pressure measurements, meal assistance	Setting up lunch while watching the patient's condition, and assisting with meals for those who cannot eat by themselves.	Having trouble with patients who won't eat or take their IV(Intravenous Injection)s.	
J-11. Calming down patients to get them to take their medicine	I have to calm down or cheer up patients who don't want to take their medicine (or won't let me take their temperature) before I can get them to take it.		
J-12. Changing (replacing) IVs			Central vein Once or several times a week
J-13. Transporting IV drips	One IV drip per patient is picked up using a freight elevator (5-10 drips per ward). The freight elevator on the 4th floor is not in the nurse's station, so it has to be carried there on foot.	Carrying many 500ml IV drips to the bedside is a burden. The freight lift on the 4th floor is far from the nurse's station (about 70m), so it is a burden to walk there to get it.	
J-14. Catheters for emergency patients	If someone with a heart attack is brought in urgently, an emergency catheter is needed.		
J-15. Postponement of scheduled tests due to emergencies		Psychological burden due to complaints about the length of waiting time, the way tests are explained, and staff attitudes	

DESIGN

Based on the institutions and services identified through qualitative text analysis, we developed five service concepts and proposed them to the hospital staff. The two concepts that were adopted were based on three factors: the fact that these are jobs that occupy a large amount of nurses' time; the recognition that these are jobs that can be carried out by staff other than nurses, both at an individual and organisational level, and that they are jobs that have a low priority for nurses; and the technical feasibility of the services.

The first service is to guide patients to their hospital rooms (Figure 3). After checking in, patients are guided

from the reception desk to their hospital rooms by a telepresence robot. Once they arrive at their hospital room, a nurse explains the hospital admission procedures through the telepresence robot. At Shonan Kamakura General Hospital, the number of inpatients per day is just over 500[39], and if it takes an average of 30 minutes to guide each patient, a total of 15,000 minutes, or 250 hours, are needed per day. By introducing this service, 250 hours of nurse labour will be reduced.

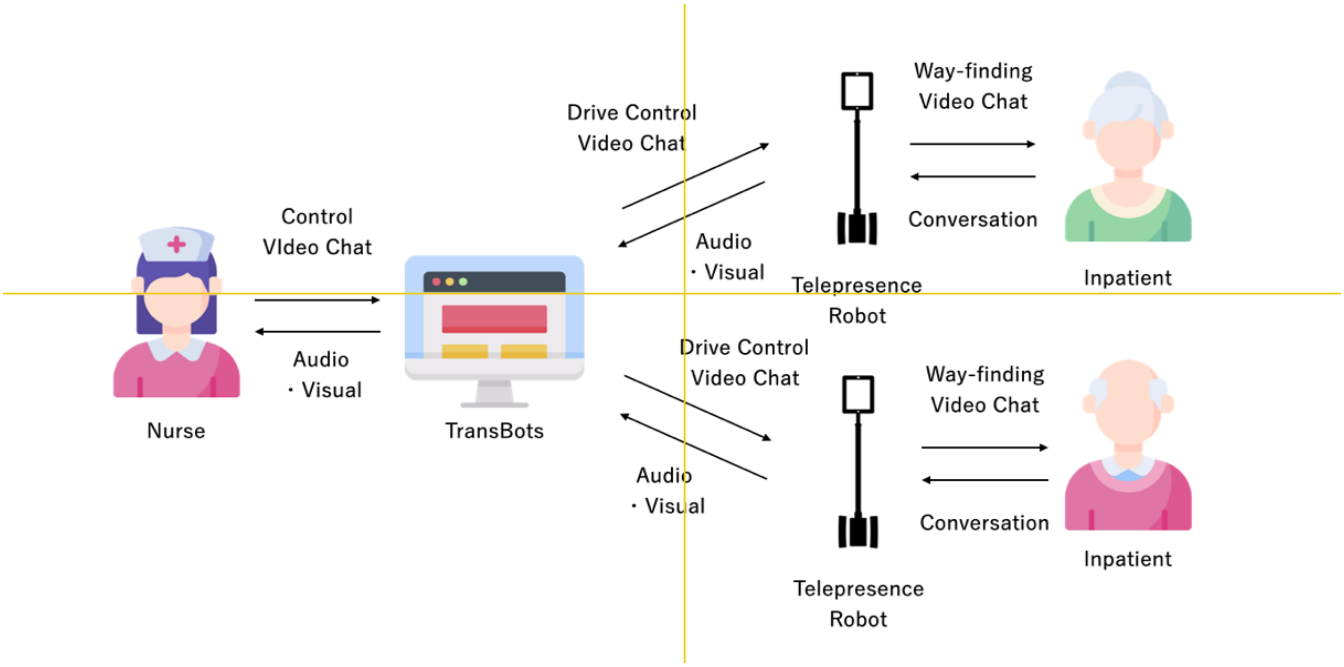

Figure 3. Guiding inpatients to their hospital room

The second service is guiding patients to the examination room (Figure 4). On days when patients have some kind of examination, the service robot goes from the nurse's station to the patient's room and guides the patient to the examination room.

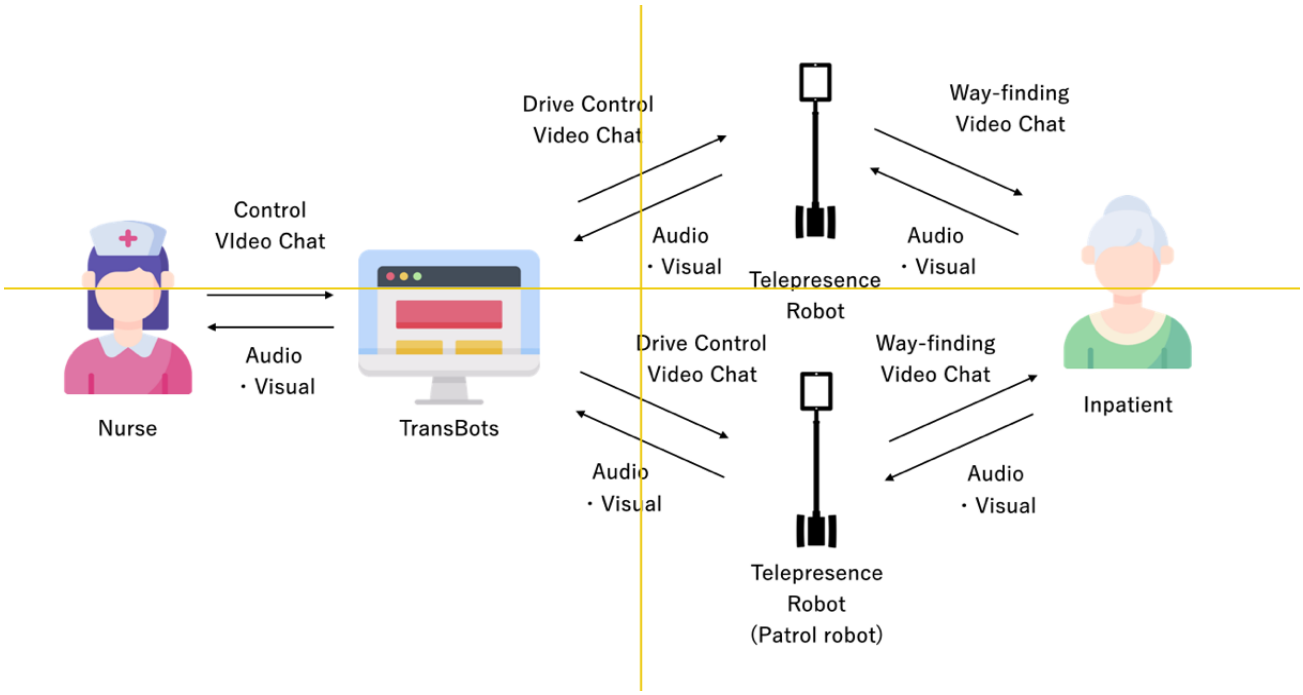

Figure 4. Guiding inpatients to an examination room

Both services were designed based on the extracted normative elements. Specifically, 'N-1: There is no rule that the nurse in charge must take the patient to their room, 'N-5: When guiding a patient, we stand next to them, at a distance where we can support them immediately if anything happens', and the cultural -cognitive element 'C-4: We try to give patients a polite explanation'.

After designing these service concepts, we organized the necessary resources for each service. Specifically, we organized the existing resources that are necessary for the nurses and patients, even if the service robots are not introduced, and the new resources that will be generated by introducing this service. We also designed a service blueprint and organized the front-stage and back-stage actions in response to the patient's actions.

EVALUATION

On 25 January 2022, we conducted a demonstration experiment for the two service concepts. The aim of this experiment was to have nurses evaluate the usefulness and safety of the service robots, and to identify issues that need to be addressed before the robots can be introduced into actual use. Regarding usefulness, the nurses qualitatively evaluated whether the service robots would be useful for infection prevention and labour support, and whether the system was easy to use. Regarding safety, the nurses qualitatively evaluated whether there were any concerns about the robots' mobility or operation.

This experiment was conducted in the ward area on the 4th floor of the main building. The service robots used were Ohmni[40] and temi[41] in order to compare and examine the operability of the robots. Two nurses participated in the evaluation experiment, with one acting as the Transbots operator and the other in charge of communication with the patients. We asked one patient to participate in each scenario in advance, and only asked them to participate if they gave their consent.

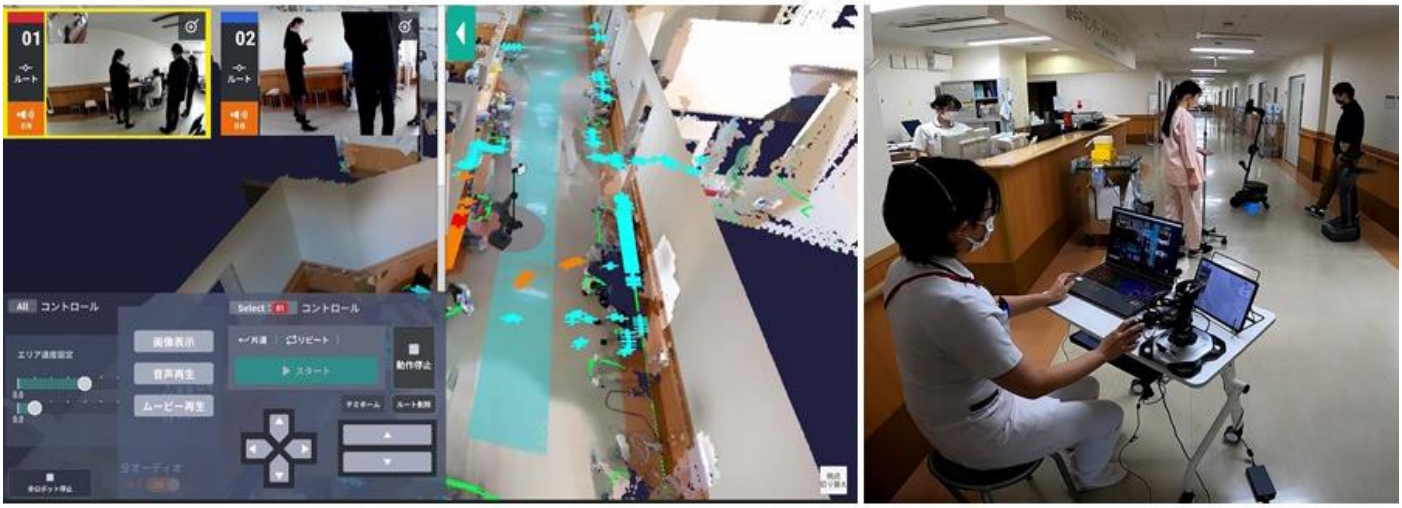

Figure 4: Transbots operation User Interface (UI)

The day was divided into three parts: operation experience, demonstration experiment 1, and demonstration experiment 2. First, in the operation experience, the nurse acting as the operator conducted the basic functions of TransBots (manual driving, automatic driving, multiple-unit automatic driving, telepresence, video chat) over a period of about 50 minutes. Next, in the first demonstration experiment, the robot guided the patient from the hospital reception to the patient's room, and the nurse in charge gave an explanation of the hospital stay using the telepresence function. After that, two patients were guided from the ward reception to their rooms by two robots at the same time, and another nurse gave them an explanation of their hospital stay using the telepresence function. Finally, in the second experiment, the patients were guided from their rooms to the examination room by a robot.

We created a scenario in which the patient would get separated from the robot, and another robot would find them and continue guiding them.

Two types of evaluation methods were used: interviews immediately after the experiment and a questionnaire survey after the experiment. The evaluation was only conducted on the nurses acting as operators. As for the patients, in light of the hospital's request to avoid contact as much as possible due to the impact of COVID-19, the experiment was abandoned.

The purpose of the interview immediately after the experiment was to collect subjective opinions about the operational trial and the demonstration experiments 1 and 2. In the interview immediately after the experiment, multiple questions were asked and answers were obtained regarding the following two verification items.

1. Ease of operation of Transbots, including control of multiple units
2. Potential of three-way communication through robots

The post-experiment questionnaire survey aimed to collect opinions, mainly on behavioural changes that occur as a result of the introduction of new services, using diagrams and other aids. In the post-experiment evaluation, we distributed a questionnaire form and asked for evaluations on the following two verification items:

1. Behavioural changes that occur as a result of service concepts 1 and 2
2. Existing or new institutions related to the introduction of service robots

For each question, we asked for a five-point evaluation and then asked for comments in free-form responses. Initially, we tried to conduct interviews with the two nurses who had agreed to cooperate with the experiment, but due to the nature of their work, they responded that it would be difficult to fix a date and time in advance and to set aside about an hour during working hours for an interview, so we changed the method to a questionnaire survey with a focus on free-form responses.

Results

INTERVIEW RESULTS

Table 4 shows the questions and answers given by the nurse playing the role of the operator in the first demonstration experiment. Although the guidance was carried out without any problems, it would be desirable to be able to make detailed settings for the speed according to the patient's condition.

Table 4: Questions and answers: Demonstration experiment 1

Questions	Answers
Q1. Did you guide the patient smoothly?	Ohmni is very slow and stops crackling, so the patient seems to stumble. temi seems to guide more smoothly. temi is … slow speed: too slow; medium speed: still slow; high speed: a bit fast.
Q2. Were there any inconveniences?	Ohmni should run more smoothly. The slow speed may cause the patients to stumble.

Table 5 shows the questions and answers given by the nurse playing the role of the operator in the second demonstration experiment. Completing the task of switching between multiple screens, operating multiple robots appropriately, finding the patient, and continuing the guidance is thought to be related not only to literacy issues, but also to proficiency issues. As the operator was a nurse, it was thought that it would be difficult for them to complete this task without any problems after a simple operation experience.

Table 5: Questions and answers: Demonstration experiment 2

Question	Answer
Q3. Did you find the stray robot?	The robot on the screen was so small that I couldn't really see what was going on. I had to get very close to the other robot to see it. Maybe I could get used to looking at two screens, but I would forget to switch monitors. I can't trust the robot in terms of safety and security. I was worried about bumping into a patient in a wheelchair or something.

QUESTIONNAIRE SURVEY RESULTS

Figure 5 shows the changes in the current job and the job after the installation of the robot expressed in the figure, and Table 6 shows the questions and answers to confirm the degree of acceptance of specific behavioural changes. The results of the answers to all questions were positive. As there was a response that guidance is a job that can be done by someone other than a nurse, it is thought that this is because the nurses themselves feel that the job can be replaced by a robot and should be replaced at their cognitive level.

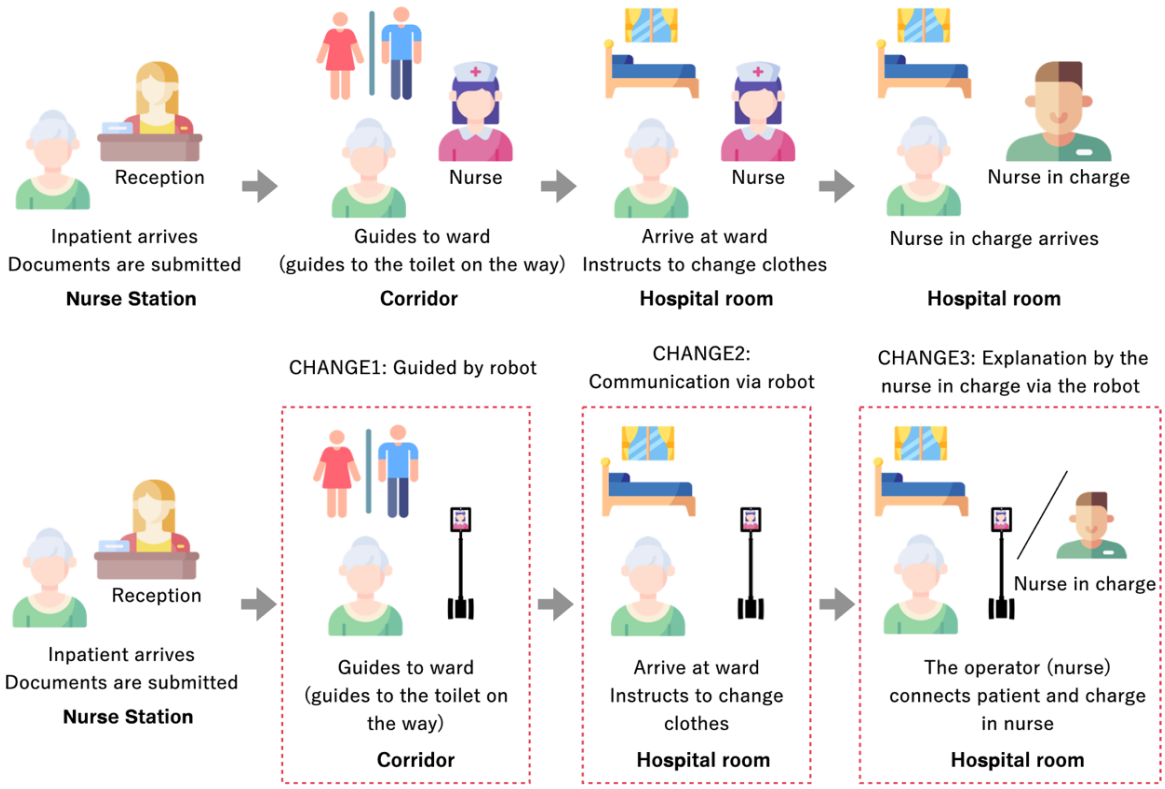

Figure 5: Changes in current jobs and jobs after robot installation
Demonstration 1: Guiding inpatients to their hospital rooms

Table 6: Evaluation of behaviour change

Questions	Answers
Q1: How do you feel about robots guiding hospitalised patients instead of people in the future?	RESULTS: 5 – I think it would be good. In a large hospital ward, there are calls and responses from other patients while the robot is going to and from the hospital. Guiding people to their rooms is a job that can be done by non-nurses.
Q2: [After arriving at the ward] What do you think about communicating with patients through the robot instead of face-to-face?	RESULTS: 4 – Acceptable. I think it depends on the patient's activities of daily living and level of understanding. Sometimes it is not possible to understand without direct contact.
Q3: [Connecting to the nurse in charge] What are your impressions of the function where the operator (nurse) calls the nurse in charge on the tablet and connects with the patient?	RESULTS: 4 – It could be improved, but it is usable. I think the operator could explain it as it is, but in the end, I think it would be better if the person in charge of the room visited the room without connecting here, because they check the location of things and the activities of daily living and set up bed fences and nurse calls. Some people also need to have blood samples taken.
Q4: [Start of guidance] What do you think about using robots (instead of people) to take inpatients for examinations in the future?	RESULTS: 5 – I think it's good. It's a job that doesn't need a nurse

Finally, Table 7 shows the questions and answers we asked to confirm existing and new institutions for installing the service. Regarding institutions, it is clear that it is possible to make use of existing institutions. On the other hand, since there is a resistance to nurses operating the service themselves, it is thought that it would be preferable to have the service carried out by an operator.

Table 7: Evaluation of institutions

Questions	Answers
Q5: Are there any existing institutions (e.g. seminars, study groups in teams) that promote the adoption of robots, IT (information technology), etc.?	We're forming a team at the deputy chiefs' meeting. Announcement on Workplace about the adoption of robots and recruitment of collaborators.
Q6: What new institutions (e.g. workplace rules, arrangements within a team, mindset) do you think are necessary for the adoption of robots?	Safe and without harm to patients Make sure that there is always a human eye on the end result.
Q7: What additional services do you think are needed to get the robots up, running and fully utilized?	The fact that people are needed to operate the robots was not what I expected. If they work automatically after being programmed, we could do other work during that time.

Discussion

HOW SHOULD WE ACCELERATE THE SERVICE DESIGN PROCESS?

Regarding RQ1, What characteristics should be introduced to each step of the design process, such as research, analysis, design, and evaluation, in order to design services rapidly?, based on a literature review, we introduced RE mainly in the steps of research, analysis, design, implementation and evaluation, and as a result, we were able to build two services in about two months from research to demonstration experiments. Specifically, in the research, we narrowed down the focus of the field research appropriately and conducted the research with nurses as the main information providers. In addition, as an important activity, we conducted the field research with a focus on the jobs and institutions of nurses. These fieldwork activities were carried out by multiple service designers. In the analysis, the data obtained from the fieldwork was analysed by multiple service designers. Here, we used qualitative text analysis to extract three institutions and jobs, and we organized the functional and psychological aspects of the jobs.

In the design stage, we allocated existing jobs to service robots using the three institutions we had extracted as constraints, and proposed two new service concepts.

In the post-implementation validation, the results of the post-interview and questionnaire survey showed that, while there were many points for improvement in terms of the UI and operational experience, the service conceptsthemselves were generally well received. Conventional HCD processes, whether they are phenomenological design theories that focus on human subjective experience[42] or anthropological design theories that focus on the social and cultural background of phenomena[43], tended to involve a lot of time for research and analysis. In contrast to these, this method, by focusing particularly on jobs and institutions, has compressed the time required for the service design process, and has also achieved validity as a service concept, so it can be said that it has contributed as a rapid service design process method.

HOW SHOULD WE DESIGN SERVICES WITH ROBOTS REPIDLY?

Regarding RQ2, What theories, tools, and methods should be introduced in each step of the design process, such as research, analysis, design, and evaluation, in order to rapidly design services with robots rather than just services?, based on the existing jobs that were extracted and the institutions that were extracted for each site, we determined the jobs to be assigned to the robot, proposed new services, and, in the evaluation step, showed the specific content of the behavioural changes for each service, and then collected opinions from stakeholders. As a result, we were able to obtain positive responses for two service concepts. Specifically, in Q3-6 of the post-questionnaire survey, we compared the workflow between the existing job and the proposed service concept, and explicitly showed the nurses what kind of change would occur. We then asked for their opinions on the content of the change, and received effective opinions for all questions. We believe that this result was due to the fact that we selected the jobs to be assigned to the robot from the perspective of the three institutions and designed the service concept.

In the evaluation step, we introduced the CREATE funnel into the service design process, so in this subsection, we will analyse the service using the CREATE funnel to identify any psychological barriers to introducing the service.

We did not considered Cue, the trigger that gets you thinking about taking a specific action, in this demonstration experiment. However, in actual operation, it would be desirable to link it to the reception and examination systems so that the nurse receives the cue.

Regarding Reaction, the instinctive first reaction to the idea of taking the action, the Transbot UI received a large number of negative opinions in both the

post-interview and post-questionnaire surveys, so it is advisable to conduct usability testing based on the target users and make improvements.

Regarding Evaluation, a more rational cost vs benefit analysis of taking the action, it is thought that if the operation is carried out by an operator who is proficient in information technology (IT) other than nurses, and if it is carried out in 1-n, then cost-effectiveness can be fully expected. In fact, in both the post-interview and post-questionnaire survey, many negative opinions were seen regarding the nurses themselves operating the system. For nurses, operating Transbots requires new operant resources. When the service idea was proposed, the nurses as well as the organisation showed a positive response. However, it can be assumed that the nurses changed their minds to a negative opinion because they found the operation of Transbots to be more complex than they had expected during the training before the experiment, and they judged it to be difficult to master. Therefore, it is thought that it would be desirable to delegate the operation to another person in the hospital who is proficient in IT and is not a nurse, or to an external operator.

Regarding Ability, seeing whether you can even take the action right now, both the post-implementation interview and the post-implementation questionnaire survey showed that many nurses had negative opinions about operating the system themselves. In order to acquire these operant resources as an organisation, in addition to advertising for suitable personnel internally, as indicated in the responses to Q7, it would be desirable to design a system that includes training sessions on operating this system and evaluating IT system use as items to be assessed. It is possible that a different response could have been elicited by having the nurses actually fully familiarize themselves with the operating methods through these opportunities before the experiment.

Regarding Timing, determining whether it's urgent to take the action right now, if the nurse is in charge, in actual operation, they will receive a cue by linking with the reception system and the examination system, and if they are engaged in a different job, there is a high possibility that they will not be able to give guidance immediately. On the other hand, if an external operator is in charge, even if they receive a cue by linking with the reception system and the examination system in actual operation, the possibility of implementation is considered to increase.

If the premise is to use an arbitrary IT platform, as in this project, we think that in the initial investigation step, in addition to jobs and institutions, the level of proficiency with IT tools should have been checked in advance. Depending on the response, even if one of the actors needed to acquire the skills and knowledge to operate Transbots, it would be possible to consider an approach where another actor who is not a nurse, such as staff from the IT department or external staff, would be asked to do so.

FURTHER ACCELERATION THROUGH THE USE OF GENERATIVE AI (ARTIFICIAL INTELLEGENCE)

This case study was conducted before Generative AI became commonplace, but it is possible to achieve further acceleration by using Generative AI in each step of the service design process. Specifically, we will explain this using a concrete example, assuming that we are building a new business in the healthcare industry.

In desk research, there are three main types of analysis that can be used to understand the market. Firstly, there is industry analysis. For example, it is possible to use Generative AI to output an overall picture of the actor network, such as what actors exist in the healthcare industry and how they interact with each other. Secondly, there is competitive analysis. For example, if we are considering a service for a particular actor in the healthcare industry, in this case a visiting doctor, it is possible to use Generative AI to analyse competing services that assume the visiting doctor as a user. Thirdly, there is environmental analysis. Of the environmental analysis, PEST analysis, which investigates general political, economic, social and technological factors, can be carried out using Generative AI.

In field research, it can be used mainly in the process of interviews and observations, with the aim of understanding people and the field. As a premise, the field research destination is considered while using the actor network output from the desk research. In observations, it can be used for observation planning, observation guidelines, and analysis of observation data. For example, when considering a new business in the nursing care industry, it can be used to consider an observation plan that includes things and spaces to observe, experiences to observe, and important contexts. It is also possible to create observation guidelines that include protocols for carrying out observations. Apart from the content explained in the interview analysis section, it is possible to analyse audio data, photo data and video data. For interviews, it is possible to design questions, create interview guides, transcribe interviews and analyse interview data. For example, when considering a new business in the nursing care industry, there are various types of people working there, in addition to the residents who are the users and customers. It is possible to have the AI generate questions for each of these groups based on their attributes. It is also possible to generate interview guides that include the precautions to be read out when conducting interviews. While the analysis of interview data is based on the use of text data, it is also possible to convert audio data into text data using Generative AI. While the analysis of interview data has traditionally been carried out by humans, it is possible to have Generative AI take over this role. For example, it can be used to extract issues and insights that can be used during ideation. It can also be used for analysis aimed at creating personas.

Once the field research has been completed and the data analysis has been completed, the next step is to generate ideas. It is hoped that various ideas will have already come to mind by the time the field research has been completed, but if ideas are not coming together well, it is also possible to use Generative AI. There are various technical idea generation techniques, such as 'SCAMPER[44]', which is made up of the initial letters of seven verbs for idea generation, 'Characteristic Enumeration Method[45]', which lists the characteristics (functions, shapes, materials, etc.) of the target product or service and then changes each characteristic, and 'TRIZ[46]', which is a set of 40 invention principles extracted from the abstracts of around 40,000 patents. It is possible to use Generative AI to come up with ideas based on these methods. After coming up with ideas, it is necessary to evaluate the ideas and select the ones that will move on to the next stage, and it is also possible to evaluate ideas based on arbitrary evaluation axes through Generative AI.

Once the idea evaluation is complete and a number of high-quality ideas remain, the next stage is to carry out detailed design of the business. Detailed design is carried out from two perspectives: customer experience and business model. First, journey maps and service blueprints are generally used to design customer/user experience. Generative AI can be used to create these. Next, for designing business models, you can use tools such as the Business Model Canvas[47], which is a tool for visualising and analysing business models using nine elements, and the Lean Canvas[48], which is a business model canvas specialised for startups. You can also use the 'service ecosystem', which expands the actor network and describes the context of providing services at the micro, meso and macro levels. You can use Generative AI to create these. Once the detailed design of the service is complete, it is advisable to conduct a concept evaluation with your target customers before moving on to the next stage. This is because the detailed design involves many hypotheses, and if you move on to the next stage without testing these hypotheses, it will be too late if the customers respond negatively to the prototype. The planning, implementation and analysis of concept evaluation can be carried out with the support of Generative AI.

After the prototype is completed and various tests, including usability tests, are completed, the implementation stage begins. As soon as implementation is complete, a demonstration experiment is carried out with the target customers.

For example, in the case of SaaS, small-scale test users are recruited and evaluated. In the case of on-site services, the service is introduced and evaluated at multiple test stores. The planning, implementation and analysis of these proof-of-concept experiments can be carried out with the support of Generative AI. In addition to the service itself, Generative AI can also be used to refine business plans and create launch and operation plans.

As described above, it is possible to collaborate with Generative AI at each step of the service design process. The examples given here are tasks that are possible at the time of writing this paper, so it is easy to predict that the quantity and quality of tasks that can be realised will continue to increase in the future. By focusing not only on institutions and jobs, but also by utilising Generative AI, it is possible to accelerate the basic tasks of each step.

Conclusion

In this paper, we have developed a 'rapid service design method' with the aim of designing services that utilize robots in the context of the COVID-19 pandemic. This service design method aims to achieve rapid service design based on behavioural change by introducing Rapid Ethnography in the steps of research, analysis, design, and evaluation. Specifically, based on the existing jobs that were extracted and the institutions that were extracted for each field, the jobs assigned to the robot were determined, and two new services were proposed. In the evaluation step, the specific content of the behavioural change for each service was indicated, and the opinions of stakeholders were collected. As a result of the interviews and questionnaire surveys in the demonstration experiment, the validity of the two services was confirmed, and the validity of this method was confirmed.

However, there are three limitations to the results of this paper. Firstly, there is a lack of evaluation data from the patient side. Due to the impact of COVID-19, it was necessary to refrain from contact with patients, so it was not possible to collect evaluation data from the patient side. As a result, there is a lack of evaluation from the perspective of the patients, who are the beneficiaries of the proposed services. Secondly, the verification is limited to a single medical facility. The project was conducted at a single medical facility. It is not possible to determine at this point whether similar results could be obtained in other healthcare facilities of different sizes, locations or specialities. This limits the generalisability of the proposed method. Thirdly, the long-term effects have not been verified. This research focused on short-term service design and initial evaluation, and did not examine the long-term effects or sustainability of the proposed services. There is a lack of knowledge about their continued use in medical settings and their long-term effects on reducing nurse workload.

The following three points can be considered as possible applications of the methods and research content proposed in this paper. Firstly, it can be applied to other medical service fields. The proposed rapid service design method has the potential to be applied to other departments within hospitals and different types of medical facilities (e.g. clinics, rehabilitation centres, elderly care facilities, etc.). In particular, this method can be effectively used in the medical field, where rapid changes and emergency responses are required. Secondly, it can be applied to other public service fields. This method could also be applied to other public service fields (e.g. education, administrative services, public transport, etc.). In particular, it could be effectively used in situations where rapid service improvements or the introduction of new services is required, such as during pandemics like COVID-19 or disasters. Thirdly, it could be considered for integration into the new service development process of companies. It is thought that this rapid service design method could also be integrated into the new service development process of private companies. In particular, it is thought to be effective in cases where there is a need to develop and introduce new services in a short period of time while taking into account changes in user behaviour (e.g. new product development in technology companies, introduction of new services in the retail industry, etc.).

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